VOL. 40.

RUDIMENTARY TREATISE

ON THE ART OF

PAINTING ON GLASS,

OR

GLASS STAINING.

BY DR. M. A. GESSERT.

TO WHICH IS ADDED,
AN APPENDIX ON THE ART OF ENAMELLING,
ETC.

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RUDIMENTARY TREATISE

ON THE

ART OF PAINTING ON GLASS,

OR

GLASS-STAINING:

COMPRISING

DIRECTIONS FOR PREPARING THE PIGMENTS AND FLUXES,
FOR LAYING THEM UPON THE GLASS,
AND
FOR FIRING OR BURNING IN THE COLOURS.

FROM THE GERMAN OF

DR. M. A. GESSERT,

Author of "The History of Glass-Painting."

TO WHICH IS ADDED

AN APPENDIX ON THE ART OF ENAMELLING, &c.

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RUDIMENTARY TREATISE

ON

THE ART OF PAINTING ON GLASS,

OR

GLASS-STAINING.

INTRODUCTION.

1. THE beautiful art of glass-painting is not only restored, in our day, to the perfect fulness of its ancient splendour, but also has acquired, through the giant strides of the science of chemistry, and the great progress latterly made in the arts of design, an amount of technical and æsthetical power, far exceeding whatever could formerly be called to its aid.

Notwithstanding this advantage, however, the art has not yet reached that wide state of diffusion which, from the exquisite effects it is capable of producing, it deserves, and which it attained in the olden time, even with its then more limited capabilities.

2. This circumscribed use of glass-painting can scarcely be accounted for by a comparison of the religious circumstances of our age with those of the past, or on the supposition that this art, confining itself exclusively to exhibition in sacred edifices, had therefore been lost among the

frivolous tastes which at present prevail. On the contrary, the works of the finest masters of the art have shown that the wonderful effects of glass-painting may be brought into use for other purposes than the service of the Church, and may be made to satisfy not less the worldly demands of our generation, than the more devotional feelings of the middle ages.

The obstacles which, on the revival of the art, have interposed to check its further extension, and therefore to diminish also the general demand for its productions, are much rather to be attributed to those in whose hands it rests, than to any thing properly belonging to itself; they originate, in fact, less in the art than with the artists.

3. One of the principal causes of the earlier decay of glass-painting was, that its rules being based so entirely upon empirical principles, those who practised it were accustomed to consider the knowledge they had acquired in the thorny path of tedious and long-continued experiment, as their most valuable personal property, forming at once the means of their subsistence, and the foundation of their future artistical fame. They therefore not only kept the information they had gained profoundly secret during their lives, but even carried it with them to their graves, in preference to leaving it behind them to be made use of by their scholars.

This easily intelligible, but not on that account the less reprehensible egotism,—this avarice for artistical monopoly, also operates in some measure to damp the speculative ardour of the present day, and constitutes, in fact, the primitive cause of the evil of which we complain.

On the other hand, the most conducive element towards the full and free development of power generally, and particularly of artistical talent, is competition. It multiplies production, invites public judgment and comparison, and calls forth a laudable emulation, tending, in return, not only to promote the excellence of the works produced, but, by aiming at popularity, also to create an ever new demand for their increase and multiplication.

4. The directions which form the principal part of the following pages have already been published at different times, in earlier communications of the same author scattered through German scientific periodicals, but have now been collected, enlarged, improved, and remodelled into the present form, in the hope that their more general circulation may put into the possession of the many that information which was formerly jealously guarded by the initiated few, and thereby such a general interest may be promoted as cannot fail to be beneficial to the art.

The recipes have been carefully selected, and their correctness and efficacy proved by many years' practice; and it has been endeavoured to make them so easy of comprehension, that neither those unacquainted with chemistry shall fail in their preparation, nor those unpractised in the art go astray in their application.

5. In the classification of the pigments into Fused and Mixed Colours, (understanding by the first all those which are fused into a glaze together with the flux before laid on, and by the second all colouring bodies burnt into the glass without such previous process, whether requiring the help of a flux or not,) the theory given by the Author in his late work on the 'History of Glass Painting' has been adhered to. This division has the advantage of avoiding those errors which had their origin in the early homonymic of *flux*, for the oxide previously melted with the flux, and for the fluxing medium itself.

It is hoped that these few pages may be the means of prompting, not only artists by profession, but also amateurs, to such an increased and successful exercise of the art, as may tend to show forth its beauties and capabilities to the world in a more general and extended manner than heretofore.

CHAPTER I.

OF THE PIGMENTS AND FLUXES; AND THE METHODS OF PREPARING THEM.

6. Glass painting or staining* may be defined to mean, the art of painting on transparent glass (either colourless or already coloured in the process of its manufacture) with vitrescible metallic colours, which are afterwards burnt into the surface of the glass on which they are laid, leaving it more or less transparent.

7. All colours used in glass-painting are oxides of metals, or other metallic combinations.

They may be divided into two principal classes—

1. Those whose colouring base, or the oxide, is laid upon the glass simply in its original combination with an earthy vehicle.

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* The words 'painting' and 'staining' seem to be used in English synonymously with reference to this art. The former of these has been adhered to throughout this work, not only because it is more in accordance with the German expression, but because it appears more calculated to secure to this species of decoration a place (which it decidedly deserves) among the fine arts; whereas, the word *staining* might simply mean the *colouring* of glass, without any reference to design.—Tr.

2. Those whose colouring base, or the oxide, must be made to adhere by the help of a glassy body,—namely, the flux.

8. The colours which require a flux may be divided again into—

1. Those in which the oxide unchanged, but only *mixed* with the flux, is attached to the glass.
2. Those in which the oxide requires to be vitrified, by previous *fusion* with the flux, before it is laid on the glass.

The last may be called *Fused Colours,* all others *Mixed Colours.*

9. The classification above given may be made clearer by the following explanatory remarks.

Glass-painting is distinguished especially from other illuminating processes, in that the colours and the foundation on which they are laid must, in this art, be fused together in the kiln.

Now, some few colours combine with the surface of the glass, at the temperature of fusion, without further previous preparation than the simple laying on; wherefore these give to the glass only a colouring cementation or stain.

Others, on the contrary, in consequence of their peculiar nature, can only be made to combine with the glass, by fusing them, upon its surface, into another thin sheet or layer of coloured glass.

This is done by means of the *flux,* a vitreous compound, which fuses more easily (*i. e.* at a lower temperature) than the foundation, the glass plate.

10. The flux may be used in two ways. With some colours it may be simply mixed before they are laid on, so as to combine, at the temperature of fusion, with their oxides, and to unite these again with the surface of the glass; but in other cases the flux must, before painting, have entered into a chemical combination with the oxides, *i. e.* must have been fused together with them into what may be called a *Fused Colour*, which latter, after being pulverized, serves as a pigment.

This process is rendered necessary in consequence of the difficulty of fusion of certain oxides, which, in order to combine with the flux, and to acquire the intended shades of colour, require a greater degree of heat than could be made use of in burning the colours upon the glass, without endangering the success of the operation.

From this description of the nature of the colours and the manner of their combination with the glass, we will now pass on to the practical directions for their preparation and use ; in assurance that the foregoing will not only prevent erroneous notions being formed of the nature of the different elements entering into the operations, but may tend to the perfect understanding and successful practice of the directions given.

Those for white and black pigments are given first, the others follow in order.

I. WHITE.—FUSED COLOUR.

11. Two parts of bone glass,* with one part minium, or red lead, are to be mixed together and melted in a covered Hessian crucible placed in a wind furnace. The mixture is then to be poured out into a flat vessel containing pure cold water, and, when cooled, is to be ground with a glass muller on a table of thick sheet glass.

MIXED COLOURS.

12. One part of bones calcined to whiteness, with two parts of flux, ground together on a glass plate.

Flux. Glass of lead (flint glass).†

13. One part white oxide of tin, with two parts of flux, ground as before.

Flux. Lead glass.

14. *Preparation of the oxide of tin.*—Melt in a covered crucible one part of pure tin cuttings. When in fusion, add two parts of nitre and stir well the mixture with an iron rod. The crucible is then to be again covered, placed in burning charcoal, and the mixture occasionally stirred as before from time to time, until it begins

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* Made by fluxing together eight or ten parts of calcined bones (bone ash), and eight of red lead, with about 80 of white glass.

† German *Bleiglas.* This, however, contains more lead than exists in our English flint-glass: a recipe for it, in one of the German Encyclopædias, is 15 parts dross of lead, and 12 parts common glass frit. The ordinary flint-glass may be made to serve by adding minium to it, and trials will show the best proportions. *See* Art. 88.

to get white on the top. Continue the stirring a little longer, then pour the mass out of the crucible into an agate mortar and let it cool. It is then to be pulverized, boiled in water, and afterwards dried.

II. BLACK.—MIXED COLOURS.

15. Two parts oxide of copper (prepared by heating nitrate of copper to redness), and one part flux.

Flux. Equal parts of crystallized borax, minium, and pounded glass, are to be mixed and melted in a crucible for about an hour or an hour and a half, in a wind furnace, then to be poured in a vessel of water, afterwards dried, and powdered on a glass plate.

16. Some oxide of iron, or of manganese, added to the former, gives that brownish tone of colour which was so peculiar to the ancient glass-paintings.

17. One part black protoxide of iron, (prepared by mixing red oxide of iron with olive oil to a moist powder, and afterwards heating the mixture in a crucible till the oil is evaporated,) one part of protoxide of copper, (prepared by submitting green carbonate of copper to a red heat, and washing it in water,) and two and a quarter parts flux.

Flux. Two parts lead glass, ground to a proper degree of fineness on a copper plate, or colour stone, with water, and one-fourth of a part gum-arabic. The latter to be added after the pigment is mixed with the glass. All are then to be ground as delicately as possible together.

18. One part oxide of cobalt, one part oxide of manganese, one part copper ashes,* and one part iron scale from a smith's forge, mixed together and heated, at first gently, but afterwards with a very strong heat, until the mixture runs freely. It is then to be poured into water, and, when cold, pulverized, mixed with twelve parts of flux, and ground fine.

Flux. One part pure white sand, and three parts litharge, are to be melted together till they flow freely, and then poured out on to a warm marble plate, or into an iron mortar; when cold, to be pounded fine and washed out with water, in order to remove any reduced lead which may be present.

19. Two parts black protoxide of iron, with two and a quarter parts of the flux described in Art. 17, and treated in the same manner.

20. One part iron smithy scales, three parts oxide of copper, and four parts calcined antimony, treated as in No. 18, and ground with three parts of flux.

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* An oxide or dross of copper of a coarse kind, known to the smelters.

Flux. One part of sand, and three parts litharge, treated as in No. 18, and ground fine with one-third borax. The borax must be prepared in the following manner: a crucible is to be half-filled with it, and put in burning charcoal until the borax becomes spongy, or is calcined. It is then to be thrown into another crucible and melted in a strong fire to a clear flowing mass, which is to be poured into cold water, and, when cold, ground fine.

21. One part of purple (see its preparation further on), three parts oxide of cobalt, three parts iron smithy scales, six parts calcined antimony, and three parts copper smalt,* treated as in No. 18, and mixed with three parts of flux.

Flux. One part sand, and two and three-quarter parts litharge, are to be treated as in No. 18, and ground fine with three-eighths of a part of borax prepared as above described.

22. Treat three parts oxide of cobalt, three parts oxide of copper, three parts iron smithy scales, and four parts antimony, with three parts of flux, as described in Nos. 18, 20, and 21.

Flux. One part sand, two parts litharge, and one-fourth part borax, treated as described in No. 20.

23. Two parts black oxide of copper, with two

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* Copper oxide fused with glass and ground.

and a quarter parts of the flux described in No. 17, and used in the same manner.

24. A beautiful blue-black may be obtained by adding a small part of oxide of cobalt to the pigments in either Nos. 17, 19, or 23.

25. A black inclining to brown is produced by a similar addition of oxide of manganese.

26. Dull or dead black, for distances, is procured from one part of copper smalt and one part crude antimony * calcined (but not so far as to lose its blackness), ground together. Or,

27. One part copper smalt, and one part uncalcined oxide of manganese, treated as before. Or,

28. One part purple, one part oxide of cobalt, and one part oxide of manganese, ground fine together.

III. RED.—FUSED COLOURS.

29. One part oxide of iron, (obtained by heating clean iron nails red-hot, dissolving them in nitric acid, evaporating the solution slowly by a gentle fire, and roasting the residuum,) three parts flux, (consisting of one part sand, one part litharge,†

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* The common ore of antimony; the sulphuret.

† *Note.*—It may be understood here, once for all, that where sand and litharge are used as flux, as directed in Arts. 32, 36, 40, and 73, both these ingredients must be pounded together, melted in a crucible by a strong fire, poured into an iron mortar,

and one-fourth part borax glass*), well fused together, until a glass rod, with which the mass is to be stirred, draws fine and clear threads from it; then the crucible, with its contents in it, is to be thrown into water, and when cool, the pigment may be separated, pulverized in an agate mortar, and ground fine on a grass plate.

30. One part oxide of manganese with eight parts of flux (one drachm of sand, and three drachms litharge), melted together and treated as above.

MIXED COLOURS.

31. One part sulphate of iron, free from copper, or oxide of iron precipitated from the sulphate, more or less heated, with two to three parts flux ground together, give all shades from a light red to a blueish violet.

Flux. Six parts white silicious sand washed and calcined, four to five parts yellow oxide of lead, and two to three parts sub-

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pounded fine when cold, and finally washed out with water, before they are added to the pigment.

But where sand, litharge, and *borax glass* are indicated for flux, as in Nos. 42, 69, 78, and 84, the sand and litharge are, as above directed, to be melted and pulverized by themselves, but the borax glass is only to be ground with this latter powder, *and not again melted with it.*

This remark will save the trouble of repeating the same directions in the above-mentioned articles.

* German *Boraxglas*, fused borax.

oxide of bismuth (made from the nitrate) finely powdered, and intimately mixed in a porcelain mortar: the mass may then be thrown into a covered crucible previously brought to a red heat, and stirred frequently with a steel rod until it flows freely. It is afterwards to be poured into water, then dried, powdered, and passed through a fine sieve.

32. Common red is given by one part of sulphate of iron heated by a strong fire, washed four or six times in hot water, dried, and finely ground on a glass plate, with three parts of flux.

Flux. One drachm of sand, and three drachms of litharge.

33. In order to give a fixedness to the colcothar, or crocus martis,* which otherwise is very fugitive, it is proper to calcine it with fine white sea-salt, previously brought to a half-glowing heat in a covered crucible; equal parts of each are then to be ground well together in an agate or glass mortar; a crucible is to be filled with the composition, and kept for two hours in an increasing fire till it is surrounded with burning coals on all sides; it may then be removed, the mass cooled, pounded perfectly fine, and washed three or four times with hot water, stirring it carefully each time with a glass tube, in order to wash the salt entirely away. When the water no longer takes

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* Yellow or reddish oxide of iron.

a red tinge, it is to be poured carefully off, the mixture again washed with cold water, dried, and ground with one part of the before-mentioned flux for use. For greater certainty the sea-salt may, previous to using, be dissolved, filtered, and recovered by evaporation of the water. Lastly, it is particularly to be advised to employ in the whole process, crucibles which have not previously been used.

34. Equal parts of yellow oxide of iron (iron ochre), yellow oxide of lead or lead glass, glass of antimony, sulphuret of copper, and sulphuret of silver, ground fine together with water, and laid on the glass without the addition of any flux.

35. One part of silver which contains copper (as for example, that of which the German small coin is made), with two parts of raw antimony (sulphuret of antimony, the common ore), melted together, reduced to powder, and mixed with red oxide of iron or colcothar. This pigment also is used without flux, and is (as is the former) to be laid on in a tolerably thick layer, which will stain the surface of the glass red at the proper temperature of fusion. What remains on the surface afterwards may be removed with a spatula.

36. One part silver, two parts red antimony, and one part sulphur, melted till clear; and mixed, for use, with two parts flux.

Flux. One drachm sand, and two drachms litharge.

37. Two parts red oxide of iron, one part litharge, one part gum, one part lead glass, and six parts of best red chalk.

The lead glass is first to be ground as fine as possible on a glass table, then the litharge, the gum, and the oxide of iron are to be added; and after these are all properly mixed together, the pounded red chalk. The whole must now be gently ground and mixed in a tall glass, with as much water as will make it the consistence of thin syrup; say four or five ounces. If the operation takes place in summer, the glass is to be put in the sun; if in winter, in the warmth of a stove, and the fluid must be most carefully preserved from all dust, yet without preventing evaporation by close covering. This is best done by inverting a glass bell over it, on whose sides the moisture will collect and flow away. The fluid must remain still three days; all the thick matter will sink and adhere to the bottom of the glass, while the liquid shows itself above on the sides in transparent rings of a beautiful red colour. It is now to be carefully poured off, more water added, as before, and the operation repeated as long as any colour can be obtained from the sediment. The colour is then to be dried in a glass colour-dish by the help of a gentle heat (best by placing it in the sun), and carefully preserved. While it is yet in a fluid state or moist, it always appears more lively and clear than when quite dry. In the latter state it is to be used like gamboge, but without grinding, which would destroy its transparency and beauty. If properly prepared and used, however, this colour excels in both these qualities the most beautiful red of the ancients.

38. Brick-red is given by one part oxide of iron, and twelve parts ochre yellow (prepared from one part oxide of iron, produced from the sulphate, and one part oxide of zinc), mixed with five parts flux.

> *Flux.* One part sand, three parts minium, and one-eighth part calcined borax; finely ground, mixed, melted, and thrown into water, dried and pounded, as described in No. 31.

39. Flesh-red is obtained by melting sulphate of iron and alum, in a coarsely powdered state, and increasing the heat till the appearance of the desired colour. The residuum is to be washed with hot water, and one to two parts of flux added thereto.

> *Flux.* Six parts white sand, washed and heated to redness, four parts yellow oxide of lead, one part borax glass, and one part saltpetre, treated as in Art. 31.

40. For dull or dark red, one part of prepared blood-stone * is to be pounded and ground on a glass plate, with three parts of flux.

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* Hematite. The kidney iron ore of Cumberland.

Flux. One drachm sand, and two drachms litharge.

41. Purple, gold-purple, purple of Cassius, is obtained by precipitation from a solution of chloride of gold, by means of a solution of protomuriate of tin. It receives, according to the greater or less quantity of tin in the mixture, and the lower or higher degree of oxidation of the solution, either a beautiful red colour of various shades, as scarlet, carmine red, rose colour, flesh colour, &c., or a violet or brown.

It is to be mixed for use with four parts of flux.

Flux. One part of silica in powder (made by calcining the purest flint three or four times in a crucible, washing it every time in pure water, then powdering it in a porcelain mortar, and sifting it through a fine sieve), one and a quarter part borax glass, and five-eighths of a part minium, melted together, and finely powdered.

42. Dissolve one part of thin-beaten gold in nitro-muriatic acid, or aqua regia, pour the solution into a glass, and dilute it with fifteen parts rain-water. Throw in one and a half part of pure tin cuttings, which have been dissolved in muriatic acid, and allowed to get cool.* While this is being added to the gold solution, the liquor must

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* Literally from the original; probably it is this quantity of the muriate thus formed which is to be poured into the gold liquor.

be continually stirred. After the mixture has stood quietly a quarter of an hour, half a part of clear urine is to be added, and all well stirred together. In about two hours the supernatant fluid is to be poured from the purple pigment, which will be found precipitated, and which is to be well washed out. When perfectly dried, put it in a flat porcelain vessel, lay a piece of paper upon it, and place it on burning charcoal till the paper is charred.

The purple pigment must be used with twelve parts of flux.

Flux. One part sand, two parts litharge, and three-fourths of a part borax glass.

43. Dissolve gold * in aqua regia. If the gold has been alloyed with silver, the solution must be poured off from the chloride of silver, which separates itself. The precipitate must be washed with some distilled water, and this latter added to the solution, which must then, unfiltered, be evaporated by a moderate heat until a thick crystalline saline skin is formed, under which, by inclining the vessel to one side, only a little of the red solution will be found liquid. The mass is now allowed to get cool, whereby it becomes thoroughly hard; it must be dissolved without delay in ten times its weight of water, and filtered, by which a small quantity of reduced gold is left behind. In order to cleanse the filter, a small

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* The German gold coins are alloyed with silver.

quantity of water must be reserved out of the prescribed weight, and afterwards this must be added to the solution.

For the preparation of the tin liquor, the crystallized salt of tin * will answer very well; if it is moist, it must be dried by pressing it between unsized paper.† One part of the salt is to be dissolved in four parts of distilled water, the solution filtered, and used immediately after its preparation, as after a time it would become turbid by attracting oxygen from the atmosphere, and would deposit oxide of tin in a white powder.

Further, dissolve one part of gum-arabic in three parts of hot distilled water, and filter it through gray blotting paper, which must be of a loose texture, or the gummy fluid will not pass through it freely.

Having now prepared the three fluids in the above-mentioned manner, mix three ounces of distilled water with twenty-eight grains of the gum solution, stir it carefully, and introduce fourteen grains of the tin solution. Rinse out the vessel in which the latter was weighed with a little water; weigh twenty-three grains of the gold solution and add it to the previous mixture, rinsing out the vessel again, but this time, instead of clear water, a portion of the compounded mixture is to be used for the purpose. The

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* The muriate.

† *Druckpapier*, printing paper, which in Germany is unsized.

colour which arises during the mixing of the fluids is a fiery red brown, but changes when burnt in upon the glass into the most beautiful purple red.

The colour may possibly be somewhat altered by the action of the acid liberated by the formation of the purple precipitate in the fluid; but this is obviated by diluting it with twice its weight of water, dissolving ten grains of bi-carbonate of potash in the same, and then first mixing it with the above-mentioned mixture of the gum and tin solutions.

In order to separate the purple, whose precipitation is at present hindered by the gum, spirit of wine is to be added to the mixture until it appears very turbid: for this purpose, about double its weight of 75 per cent. spirit is necessary, if the bi-carbonate of potash has been added, otherwise three times the weight. In the course of an hour, if the mixture has been occasionally stirred during the time, the purple falls down in red-brown flakes, and the fluid remains clear, or at least very little coloured. This must then be decanted, some more spirit of wine poured over the precipitate, and the whole dropped into a filter. It must afterwards be gently pressed out between blotting paper, the precipitate removed, and ground in a rubbing dish or saucer, with weak 50 per cent. spirit of wine, to a thin pulp, which is to be heated* three minutes in a suitable vessel, and then poured into a cylindrical glass. This operation is to be repeated, and the gum will then be all removed except a little harmless remnant, which is essential to be done. Should the purple fall slowly from the last solution, and exhibit an inclination to re-dissolve, or form a clear red sheet tight upon the bottom, a little more strong spirit of wine must be added after the water is poured off, so that the purple may be made to coagulate to a thicker consistency, and the last portion of fluid afterwards filtered away. The precipitate must, as before, along with the filter, be pressed between blotting paper, taken off with a blunt knife, and dried in a porcelain dish, whereby it becomes much reduced in size, and takes a perfectly dull colour.

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* *Kochen*,—literally, boiled or cooked.

For use, the purple is to be levigated on a stone with water, until a clear deep-coloured thickish fluid is obtained. Two to six* parts of flux are then to be added, the levigation continued, and afterwards the whole dried in a porcelain dish. It may then be made fit for the pencil with thickened oil of turpentine, like other glass-painting colours.

* *Flux.* Eight parts white silicious sand, washed and calcined, four parts borax glass, one part saltpetre, and one part white chalk: treat as in Art. 31.

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* For the reason of the indefinite proportions given here and in some other places, see Art. 88.

IV. BLUE.—FUSED COLOURS.

44. Three parts oxide of cobalt, prepared in the following manner. Clean, roasted cobalt ore (zaffre) is to be dissolved in pure diluted nitric acid, at a gentle heat, until the solution is saturated; add water, precipitate the oxide with carbonate of soda, and wash the precipitate with hot water. It is then to be dried, mixed with three times its weight of pure dry nitre, placed in a crucible, and ignited with live coals. When the slight decrepitation is over, the oxide of cobalt is to be heated to redness, washed out, and dried. Three parts of this must now be melted with two to five parts of flux (composed of* eight parts washed silicious sand, four to six parts borax glass, one to two parts nitre, and one part white chalk), melted in a strong fire for an hour and a half, and ground fine for use.

45. If the cobalt ore can only be obtained raw, and it becomes necessary to roast it, the best Spanish or Swedish must be chosen, which may be tried by solution in nitric acid, diluted with two-thirds of water. The ore which gives the finest red colour in the solution is the best for the purpose, and should be chosen for the preparation of the colour. In order to free it from arsenic, it must be laid on and surrounded with

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* A misprint in the original alters the meaning of this passage; but the sense given in the text is evidently the true one.

charcoal on all sides, and burnt until the arsenic is deposited in white crystals on the walls and stones around, and the cobalt has attained a more metallic state and lustre. This operation, however, it must be remarked, requires the greatest care and precaution, on account of the dangerous vapours which arise; and if a place is not properly set apart for it, it should be performed in the open air.

46. Another blue fused colour is given by one part oxide of cobalt, and four parts borax glass, melted by a strong fire for four hours. The difficulty of fusion of the cobalt requires that this colour should be ground, for use, with two parts of flux, obtained by melting together one part rock crystal, and one part borax glass, throwing them in water and grinding them fine.

47. For dark blue, mix intimately four parts king's smalt, and about two and a half parts minium, in a porcelain mortar: set the mixture in a glazed crucible in a very strong fire, until perfectly clear glassy threads of a beautiful azure blue can be drawn from the mass. It must then be taken out of the crucible with a hook, dropped into cold water, and afterwards dried and finely powdered for use.

The proportion of minium must be varied according to the variable fusibility of the smalt which is used.

48. One part black oxide of cobalt, six parts

powdered white glass, and two parts minium; then two parts nitre; treated as the foregoing.

49. One part king's blue is to be melted with three parts borax glass, pounded, and then ground with two parts of flux of the same kind, and treated in the same manner as No. 46.

50. Light blue is given by equal parts of best king's smalt, white glass (pounded in a bright iron or porcelain mortar and sifted), and minium, mixed and melted, as in No. 47.

51. Two parts zaffre, eight parts finely powdered white glass, six parts nitre, and six parts minium, mixed, melted, and ground, as the preceding.

MIXED COLOURS.

52. Let roasted cobalt (ore) stand quietly for two or three days in nitric acid, diluted with two-thirds of water, placing it from time to time in hot ashes. When the mixture has gradually become a clear and fine red colour, pour it very carefully off so as to avoid letting any of the sediment go over with it. To the latter may be added water and more nitric acid, to extract any more red colour which can be obtained from it. The several solutions are to be mixed together in a porcelain vessel.

To six parts of this red solution add two parts of the whitest sea salt, purified as previously described, and when the latter is dissolved, pour the fluid from the sediment (which is useless) into a porcelain vessel, and set it in hot ashes. Let it evaporate some hours, and as often as new sediment is formed, pour the fluid carefully away. Continue the heating of the latter, and stir it well, especially when it begins to thicken, with a glass rod, until at last it changes into a granulous salt of the most beautiful blue colour. This salt also is to be left an hour or two on the hot ashes, and is then to be put in the open air for a few days until it becomes crimson red. It is then to be replaced in the ashes, when it becomes blue, and again in the air, when it becomes red again, and this process is to be repeated until no more nitrous gas * is evolved when the salt is heated, and until a sample of it, placed in a small glass with a little water poured over it, becomes red in half an hour, without imparting its colour to the water. When this point is arrived at, wash the salt carefully out, dry the now deep red coloured pigment in a porcelain dish, in hot ashes, and bring it once more over glowing charcoal, where it changes into a beautiful constant blue.

One part of this is to be mixed for use with two and a half parts of flux.

Flux. One part rock crystal, and one part well fused borax glass, pounded together, melted, thrown into water, powdered in an iron mortar, and ground fine on a glass plate.

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* *Salpeterdünste*, nitrous vapour.

V. YELLOW.—FUSED COLOURS.

53. Jonquil yellow is obtained by melting together one part antimonic acid, two parts of a calcined mixture of equal parts tin and lead, one part carbonate of soda, and twenty-four parts of flux, composed of one part white silicious sand, washed and calcined, and three parts minium.

54. For citron yellow, mix and melt together two parts sand and six parts litharge; pour the mass into an iron mortar, and afterwards pound it fine. Then mix with it one part oxide of silver, and one-fourth part antimony ore (antimony of commerce), and grind the whole well together; melt by a strong fire in a Hessian crucible; pour in cold water, and grind for use.

MIXED COLOURS.

55. Mix fine powdered antimony with one and a half times its weight of saltpetre, decrepitate the mass in a glowing crucible, and heat it to redness for a quarter of an hour; powder it when cold, and wash it with boiling water. The remaining white powder, which consists of the bi-antimoniate and bi-antimonite of potash, must be moderately heated in a crucible for an hour, with an equal or

from that to a double weight of minium, and mixed with equal parts of flux for use.

Flux. One part white silicious sand, washed and calcined, and three parts minium, ground together, and melted as in Art. 31

56. Uranium ore must be broken to pieces and roasted, afterwards dissolved in nitric acid, the solution filtered, and the lead which may be present precipitated by dropping in sulphuric acid. The clear green solution must then be evaporated to dryness, and kept at a red heat until it is changed into a yellow saline mass. One part of the preparation so obtained is to be ground with three parts of flux.

Flux. Four parts minium, and one part flint powder, melted together and pulverized.

57. Cut one part of pure thin-beaten silver in pieces, and break one part raw antimony and one part of lump sulphur to powder. Cover the bottom of a crucible with these two last-mentioned substances, lay upon them a piece of the silver leaf, and repeat the operation till all is laid in. Place now the crucible in red-hot charcoal, and cover it with one piece of the same. As soon as the sulphur begins to burn, the mass is in fusion. It must then be thrown into clear water, dried, mixed with three parts of dark-burnt ochre, and pounded perfectly fine.

The pigment may be used without the addition of flux or gum, and laid, to the thickness of the back of a knife, on the reverse side of the glass. The superfluous quantity may be brushed off after burning.

58. For a light yellow, proceed as in the former case, only using one part of ochre instead of three.

The portion of the yellow colour described in the last article, which may remain after the burning, may be used again for colouring matter.

59. The peculiar yellow of the ancient artists is obtained by the following process:

Melt two parts of good sulphuret of antimony with one part of silver tolerably free from copper; stir the mass together and pour it in a metallic mortar, pulverize the resulting sulphuret of antimony and silver, when cold, in the same mortar, and preserve it in a stopped phial. From this one part is to be taken, levigated with water on a copper table to the finest consistence, and mixed with four to seven parts of yellow ochre, twice heated to redness and washed in water, according to the proposed lighter or darker shade of the colour. Lay on as in No. 57.

60. Chloride of silver, and three times its weight of burnt ferruginous clay (burnt clay out of a baking oven, previously pulverized and sifted), are to be levigated with water, and laid on as in Art. 57.

61. One part sulphuret of silver, one part glass of antimony, and one part burnt ochre, ground as

fine as possible and treated in the foregoing manner.

62. For orange, dissolve pure silver in pure nitric acid, and precipitate it by hanging a piece of polished tin or copper plate in the solution. The flocculent precipitate is to be gathered together, washed in warm water, and ground fine.

One part of this to be mixed with one to two parts of the red colour, No. 37.

63. One part of silver in powder, precipitated from the solution of nitrate by a piece of thin copper, must be washed in warm water, ground with one part red and one part yellow oxide of iron, and laid on as in No. 57.

VI. GREEN.—FUSED COLOURS.

64. One part green carbonate of copper, prepared by precipitating it from a solution of copper in nitric acid with carbonate of potash, and afterwards properly washing and drying the precipitate; four parts powdered white glass, and two parts minium, must be well mixed in a porcelain mortar, and exposed to a very strong fire in a glazed crucible, until threads drawn out appear perfectly clear. It must then be taken out of the crucible with a hook, thrown into water, dried and pulverized.

65. Four parts oxide of copper, one part of antimonic acid, or antimoniate of potash, and six parts flux (composed of six parts sand, four parts

yellow oxide of lead, one part borax glass, and one part nitre), to be melted together and ground fine.

66. One part copper precipitate, (obtained by dissolving sulphate of copper in eight times its weight of boiling water, and precipitating the copper by keeping a piece of polished iron in the solution for twenty-four hours, washing the precipitate with hot water and drying it,) four parts pulverized white glass, and two parts minium, treated as in No. 64.

67. One part oxide of copper, ten parts antimoniate of potash, melted with thirty parts flux (viz. one part sand and three parts minium).

68. One part borate of copper, (obtained by dissolving pure sulphate of copper in water, and precipitating it with a solution of borate of soda, washing and drying the precipitate,) three parts white powdered glass, and one part minium, mixed and treated as in No. 64.

MIXED COLOURS.

69. Dissolve three parts pure oxide of cobalt in nitric acid, and two parts tin chippings in muriatic acid; both solutions are then to be thrown together into one glass, and precipitated with carbonate of potash. The precipitate must be collected on blotting paper, washed, dried, put in a muffle on a porcelain pot, and exposed for about

eight hours to a yellow heat, being frequently stirred in the mean time. When cold, one part of this green is to be mixed with four parts flux.

Flux. One part sand, two parts litharge, and one part borax glass.

70. Equal parts of chromate of potash, and sulphur, are to be mixed and melted together in a covered crucible. As soon as the mass flows quietly, it is to be poured off and freed from the liver of sulphur which will have formed, by well washing with boiling water, when the oxide remains as a beautiful green pigment. This is to be collected on a filter, dried and ground fine. One part of it may be mixed for use with three parts flux, laid on and burnt in.*

Flux. Four parts minium and one part flint powder, melted together to a perfectly transparent glass.

71. One part of pure yellow chromate of potash ground together with three parts fine powdered quartz, laid on and burnt in.

72. One part black oxide of manganese, and two parts cobalt or king's blue, mixed together and ground fine.

73. Two parts pure oxide of cobalt, ground with one part flux.

Flux. One drachm white sand, and two drachms litharge.

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* There is a misplacement of words in the original here, which creates some confusion.

Nos. 72 and 73 serve for green distances.

VII. VIOLET.—FUSED COLOURS.

74. Calcine best oxide of manganese in a potter's kiln with an equal quantity of saltpetre; take one part of this, six parts white glass in powder, and two parts minium; mix and treat in the manner already explained, with the strongest melting fire.

75. One part calcined oxide of manganese, one part zaffre, ten parts white glass powder, and four parts minium, treated as before.

MIXED COLOURS.

76. Gold purple mixed with chloride of silver, in varying proportions as practice will direct. The latter must previously have been melted with ten times its weight of flux, prepared from three parts white quartz, washed and calcined, five parts calcined borax, and one part minium. The gold purple is to be mixed with this, and the whole ground together.

The gold purple may be precipitated in combination with the chloride of silver by the following process. Drop into a large quantity of water, first some solution of tin, then a little nitrate of silver, and lastly the gold solution, constantly stirring the mixture. The proper proportionate quantities of the three solutions must be ascertained by experiment. The precipitate must be mixed with about an equal quantity, or rather more, of the flux.

> *Flux.* Eight parts sand, four parts borax glass, one part nitre, and one part white chalk, treated as in No. 31.

77. Gold purple ground together with three parts blue colour, and oxide of cobalt or king's smalt. This mixture gives the most beautiful violet colour, which may be made to assume different shades according to the greater or less quantity of purple, and the lighter or darker blue used.

78. One part purple, and six parts flux, ground together, give dark violet.

> *Flux.* One part sand, two parts litharge, and one-fourth of a part borax glass.

79. Mix pure gold purple after precipitation and washing, but without previously drying it, with some flux.

> *Flux.* One part silicious sand, washed and calcined, and three parts minium, treated as in No. 31.

VIII. BROWN.—FUSED COLOURS.

80. One part oxide of manganese, and eight parts flux (from one drachm of sand, and three drachms of litharge melted together), pounded and ground fine.

81. One part oxide of manganese, one-fourth

part blue of No. 52, and eight parts of the foregoing flux, used in the same way.

82. Two parts gold yellow of No. 57, one part antimony, and three parts flux (prepared from one part sand, two parts lead, and one-fourth part borax, melted together), powdered and ground fine.

MIXED COLOURS.

83. Red oxide of iron, prepared by precipitation with carbonate of potash from pure sulphate of iron, and afterwards heating the precipitate to redness until it becomes a lively red colour.

> *Flux.* A quantity of lead glass equal to that of the oxide, and some gum water, ground on a glass table.

84. Two parts oxide of iron, three parts oxide of manganese, and three parts gold yellow of No. 57, melted together, poured into water, and when cold, mixed with three parts flux.

> *Flux.* One part sand, two parts litharge, and one-fourth part borax glass.

85. Red oxide of iron (hematite, red chalk, or natural iron rust), with oxide of manganese, or a small portion of sulphuret of antimony and silver, or some oxide of silver, treated as in No. 83, serve the same purpose.

86. Or, the sediment left in the preparation of the red colour may be laid on the glass without further preparation.

87. Lastly, seven parts gold yellow of No. 57 ground with one part oxide of manganese, without melting or adding any flux.

(No. 81 gives sepia; 82, a yellow-brown.)

GENERAL REMARKS UPON THE PREPARATION OF THE PIGMENTS AND FLUXES.

88. As an essential addition to the foregoing, we may here give some few general directions respecting the preparation and combination of the pigments and fluxes, which could not well be inserted in the recipes themselves.

It is impossible to give any absolute or positive instructions for the proportionate quantities of the ingredients used in the pigments or fluxes. The determination of these must in a great measure be left to the trials and experience of the artist.

The same will apply also to the proportionate quantity of the flux to be used with the pigment, and to the quality of the flux also.

89. The materials of the colours, as well as of the fluxes, must be as good and as free from foreign ingredients as they can be obtained; otherwise disadvantageous consequences for the beauty and durability of the painting are to be feared.

90. When pigments, or fluxes, or both, are to be melted together, this must be done in strong Hessian crucibles, which are to be protected from

the action of the melting mass by covering them internally with a mixture of chalk in water. Or they may be glazed, which especially prevents the penetration of fused colours containing oxide of lead. To effect this latter object, the crucible is to be rinsed out with water, then covered on the inside with pulverized white glass, placed in the fire, and heated until the glaze adheres perfectly to its sides.

91. For the operation of fusion in Hessian crucibles, it is necessary to use an ordinary wind or air furnace, furnished with a dome or cover having a draught-pipe. The inside is to be covered everywhere with fire-clay, to a thickness of three inches, and in the cover must be a door, or at least an opening, filled up with a clay stopper, by which the interior may be accessible, in order to lift off the cover of the crucible and to stir its contents with a polished glass rod. Upon the grate of this furnace must be laid a pot of clay, and upon this the crucible, which must be covered with an earthenware lid.* It may then be surrounded with wood charcoal.

92. The ingredients of the pigments which are to be fused must previously, unless particularly directed otherwise, be ground to the finest powder on a thick glass plate with a glass muller, or, where specially indicated, upon a copper table with a steel muller, and not generally upon marble,

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* Thonscherben,—literally, a pot of clay.

porcelain, or substances containing lime, for these, by the process of rubbing, are liable to give off a portion of their material. The ingredients must be intimately mixed: the crucible is first (unless otherwise specified) to be brought to a red heat gradually, and the mixture then placed in it, but never in greater quantity than will three parts fill it.

In like manner must the ingredients of the flux be treated, and also those of the pigments and fluxes which have to be melted together to form a fused colour, provided that nothing appear in the recipes to render another mode of treatment necessary for the particular case.

The crucible must then, as a general rule, be kept some time at a moderate red heat, which is afterwards to be increased till the mass is perfectly melted and runs freely, and till threads drawn from it with a polished steel rod appear pure and clear. It must then be poured into a dish of cold pure water, afterwards dried, pulverized, and treated according to the special directions.

93. The pigments and fluxes thus prepared are to be tested in the following manner. Place a spacious crucible in a furnace in an inclined position, and put in this strips of the same kind of glass which it is proposed to paint on, streaked with the colours which are to be used. These are to be exposed to a lively red heat in the crucible

until they become weak and begin to bend, when they must be laid to cool on the top of the furnace or in the ash-pit, and afterwards examined.

Should the edges of the painted parts appear as if the colours had overrun their bounds, this is a sign of the super-saturation of the pigment with flux, and the latter must accordingly be reduced in quantity till the appearance is removed; otherwise the whole success of a glass-painting might be destroyed, for such easily fusible colours are apt to blend together when laid near each other.

On the other hand, the dull appearance and rough feel of the colours betray a deficiency of flux, which must therefore be added in greater quantity.

94. The various shades and transitions of the principal colours may be obtained, not only by the directions as to the materials and treatment given in the special recipes, but in more frequent cases and much more comprehensively, by certain manipulations which will be hereafter mentioned in the description of the manner of laying the pigments on the glass.

95. Independently of the fluxes named in the foregoing recipes for each special pigment, there are others which may serve for every colour, or at the most require a trifling variation in the peculiar proportions of the quantities of their ingredients. These proportions depend principally upon the greater or less fusibility of the pigment, and will

be easily discovered by the practised artist. Such a flux, for example, is four parts minium and one part powdered silica; the latter obtained from the purest flint, free from calcareous specks, by heating it to redness three or four times in a crucible, throwing it every time into water, and afterwards pounding it in a mortar* and sifting it through a fine sieve. This powder is to be mixed as intimately as possible with the minium, melted in a covered crucible, stirring the mass frequently with a glass rod, until it is transformed into a perfectly transparent yellow glass, the silica being entirely dissolved, and threads, drawn by way of test from the mass, being perfectly clear. It is then to be pressed out in water, dried and powdered, sifted through a fine sieve, and kept in closed bottles.

Or one part rock crystal is to be pounded and melted by a strong fire, with one part of well-fused borax glass, and treated, when it shows the before-named signs of perfect fusion, in the foregoing manner.

Or one part powdered white glass and two parts minium may be prepared in the same way.

96. Besides the implements already named, the following are necessary for the manipulation of the processes for preparing the pigments and fluxes; namely,—coal-shovels, fire-hooks, crucible tongs, hooks of polished iron for drawing the

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* A porcelain mortar is mentioned, but this must be an oversight. See Art. 92.

melted masses out of the crucibles, mortars of iron and porcelain, colour dishes, &c. of the same material or glass, spatulæ of iron and wood, and other things which can always be obtained without much trouble or expense, or indeed may be supplied from common household utensils.

In the absence of a proper wind furnace, a common round stove, like those used for warming the German apartments, may easily be adapted to the purpose.

97. All vessels which come into immediate contact with the pigments or fluxes, especially those used for their preservation, mixing, fusion, &c., must be kept as clean as possible, and carefully freed from all refuse after every time of using, lest by an accidental mixing of heterogeneous ingredients the fruit of the labour should be lost. Great caution is especially necessary in employing crucibles which have been used before.

CHAPTER II.

OF THE PROCESS OF LAYING THE COLOURS ON THE GLASS.

98. THE manipulation of the process of laying the colours on the glass varies, in some measure, according to the different kinds of glass-painting, which therefore call for the first explanation.

Either the colours may be laid upon a single sheet of glass, upon which the whole figure with all its principal colours and intermediate tints are burned in (Peinture en apprêt); or,

The figure may be composed of various pieces of *pot metal* (glass already coloured in its manufacture), and only the outlines and shadows painted on, the glass pieces giving the colours for the peculiar places where they are inserted (Mosaic glass painting); or,

Both these methods may be combined in one and the same picture, by composing it partly of pieces of coloured *pot metal* and partly of white and painted glass, fixed together.

PEINTURE EN APPRÊT.

99. For painting on a single sheet of glass, the following rules must be observed.

A pure white glass must be chosen for the purpose, free from air specks or bubbles, and especially difficult of fusion, as the whole labour would be lost if it were attempted to burn in the colours upon a ground which fused as easily as themselves. It is practicable, as the examples of the ancients show, to paint on what would appear the commonest glass with a good result, provided that it does not contain too much lead, and thereby become too easily fusible.

Before the operation of painting, the glass plate must be rubbed to a sufficient extent with pure lime, slaked by exposure to the air, in order to clean it perfectly.

100. The ground or foundation must then be laid over the whole surface of the plate, which may be done in two different ways. Some artists simply dip a piece of clean linen cloth or a flat camel-hair pencil in oil of turpentine, and brush the pane of glass with it equally over its surface; while others give to the whole a thin clear ground of black glass-painting colour, in such manner as

not to destroy its transparency, but at most to give it the appearance of a dead ground glass. Both methods answer the purpose of covering the glass with a viscous surface, which takes the design and the colours better than a polished ground; the latter prepares the glass at the same time for the painting effects which are to be obtained upon it.

In both cases the ground which has been laid on must be most carefully levelled over and brought to as thin a coat as possible with a large hair pencil, and must be dried quickly, taking great care to preserve it from dust, &c.

101. Painting on one sheet requires only one pattern drawing or cartoon, which, however, may be used in two ways.

Either the glass sheet, grounded and dried as above directed, may be laid upon the drawing, and the outlines, as seen through the glass, traced lightly with a fine pencil, and with black or other glass colour corresponding to the ground;

Or the drawing may be placed reversed on the sheet, and all the outlines marked over with a steel or ivory style. If this latter method is used upon a ground of simple turpentine, the back of the drawing must previously be rubbed over with black-lead, so that the traced lines may appear dark on the light ground.

In both cases, the drawing, whether it is placed upon or under the glass, must, for the sake of convenience, be fastened to it with pieces of wax at the four corners.

102. For properly carrying out the process of laying on the colours, a desk or easel is necessary, which should be capable of being placed in an inclined position by means of props, and should be formed by fixing a glass plate in a wooden frame, so that the light may pass through the painting. Sometimes during the progress of the work, the glass which is being painted may be removed from the easel and laid upon a sheet of white paper, in order better to show the effect of certain colours.

103. The vehicle with which the pigments are laid on is generally oil. Some artists use exclusively water, but this alone is an insufficient medium for binding the metallic bodies to the glass, particularly if, as in the case of fused colours, they are somewhat coarse in their nature, and require to be laid on in thick layers. They then easily loosen from the plate before the firing, and render the process of laying on much more difficult. It is an important advantage, that with oil the edges are more sharply defined, and the parts already painted may be again touched over when dry without danger of loosening the ground.

It must be understood that when it is wished to make use of water, the plate must either not be grounded at all, or only with a glass-painting colour worked up with water.

The most suitable kind of oil for the purpose is rectified oil of turpentine, somewhat thickened by standing, and to which a little oil of lavender is added. This preparation gives the mass the necessary degree of viscosity, and also prevents the colour on the palette from drying up and thickening too quickly.

The palette should be of thick sheet glass, ground rough by rubbing with a glass muller and fine sand.

104. Preparatory to mixing with oil for laying on, those colours which require a flux must (unless a different process is specially indicated) be ground fine in water with the flux, and again dried. But the fused colours, *i. e.* those in which the oxide has already been vitrified with the flux into the state of a transparent glass, should, for the purpose of laying on, only be coarsely granulated; for the finer these are ground, the more likely is their transparency and perfection to be impaired when burnt in.

Those pigments which are laid on in their simple combination with an earthy vehicle, and without flux, as, for example, the yellow and red colours prepared from silver, form an absolute exception to the use of oil, and must, for laying on, be stirred up with water to the consistence of a thick cream.

The first of these three kinds of pigments should, as a general rule, be laid on in a thin, the two latter in a pasty, state. The depth of tone of the colour depends, with all three, upon the degree of thickness in which the pigments are laid upon the glass.

The laying on of the fused colours is accompanied with more difficulty than that of the other kinds. The latter are simply laid on with the pencil, in the same manner as with other kinds of painting, and the only care necessary is that the coat may be perfectly equal and regular, wherefore for large surfaces a wide smooth pencil or driver is usually employed. The colours prepared from silver must be treated differently, and laid on the glass at least to the thickness of the back of a knife.

But the fused colours must be brought upon the surfaces to be covered in the state of a thick flowing mass, moist enough to run, but consistent enough to lie upon the glass. For this purpose small portions must be laid on and spread out with a pencil or small spoon, and made to flow to the circumscribing outlines, by inclining the sheet in the proper directions. If any part of the surface thus covered is required to take a darker tone of colour, the plate must be kept for some time at an inclination in the corresponding direction, so that the colour may thus accumulate thicker on that part. By this process many gradations of tone may be obtained from one and the same pigment.

105. The remaining rules for the laying on of the pigments are those which principally result from the different methods of painting on one sheet, of which there are principally three.

Either the whole picture may be brought out in its outlines and shadows, on one side of the sheet, with black, brown, or gray colour, and illuminated with the proper colours in the proper places on the other side;

Or simply the manner of ordinary oil-painting may be adopted with the glass colours, and the picture treated as by an artist in oil;

Or, as is now most customary, both methods may be united, the artist making use of each in certain places, according to the requirements of the object he has in view.

For these three methods the following common rules will serve.

106. The shadows and dark-coloured outlines, and that which is called in oil 'under-painting,' should be drawn on the front side of the glass, or that which is turned towards the spectator.

The illuminating colours, especially the principal ones, should be laid on the back or reversed side.

Intermediate tints, and gradations by shading, should generally be placed on the front side, but sometimes, when they alternate with each other, necessarily must lie on both; as they cannot be put in contact on one and the same side without danger of running into each other and making a false colour.

The silver yellow and red colours, before alluded to, must always be placed on the back or reverse side.

In some particular cases colours may be laid on corresponding places on both sides of the glass, in order to produce certain effects by the light falling through the two together. Thus, purple on one side and gold yellow on the other give a magnificent fiery scarlet; blue and yellow, according to their respective intensities, give different shades of green; the latter, again, with blue on the opposite side, serve for excellent distance colours. And finally, by the mixture of several colours, the most diversified intermediate tints may be obtained, so that glass-painting in its present state may be brought to assimilate with oil-painting in its power of producing varied effects.

107. In order to put a new tone of colour on a surface already marked with outlines, &c., it must first be dried by a gentle and equal heat (to avoid the warping of the glass), and again painted immediately after it has cooled. Or the black lines first laid on may be at once burnt in, and, where possible, with these any yellow shades also which may be required, after which the painting, then fixed, may be further worked upon without danger of damage. The residuum of the unfluxed yellow

colour may be removed after burning, and again used. This colour must never be put over any other, nor over dark shadows, unless these are previously burnt in, but always requires a carefully cleaned surface of glass to lie upon; otherwise it would combine with the flux of the under colour, whereby the earthy residuum would be fixed, and the transparency and beauty of the whole destroyed.

108. All pigments must be laid on somewhat darker than in other kinds of painting, as they lose in depth by burning.

When a pigment has overrun its outline, the superfluous quantity must be removed, when dry, with a knife.

By taking away the ground with a style of fine grained wood, pointed in front and smooth at the back (a tool used in etching), the most effective lights may be obtained.

Should the colours not appear quite dull and dry, but shining and greasy, after the drying of the picture, this is caused by the misuse of the oil, which is always dangerous to the beauty of the pigments in firing.

It is neither necessary nor advisable to allow more than one day for the drying of the colours; the burning in should be proceeded with at the expiration of the time named.

Lastly, during the work, the greatest cleanliness must be observed throughout, the pencil and palette must be kept perfectly clean, and the painting preserved from dust, &c., for which reason it is not advisable to paint in a laboratory or melting-room, where the presence of vapour, dust, and impurities of many kinds cannot be avoided.

MOSAIC GLASS-PAINTING.

109. The before-mentioned rules for laying on the colours will apply also to the method ot forming designs with coloured pieces of pot metal, or partly with these and partly with painted white glass. It remains to say something more in reference to the employment of the cartoons, and the cutting and arrangement of the glasses in this branch of the art, which, however, is but little practised, since the leaden bars in a picture calculated for a near view are detrimental to the effect.

Mosaic glass-painting requires two cartoons. One of these, a finished and coloured one, is used by the artist as a pattern, and serves to determine the arrangement of the pieces of glass according to their several colours, and the manner of introducing the leaden ribs to fasten them together, according to the outlines of the figures. Each piece of glass proposed to make part of the picture must be distinguished by a separate number.

The other cartoon, which consists only of the black outlines of the lead jointing, and whose several parts are numbered to correspond with the first, is to be cut up in pieces according to the outlines, and the size of each piece diminished all round by one-half the thickness of the lead bar of the jointing, so that the pieces of glass may be exactly cut to the proper dimensions.

The cutting of the glass may either be done by the diamond, or by tracing the line of division with a red-hot iron, after having made a small incision at its commencement, or by cutting with scissors under water, which, however, is not a safe process.

110. With overlaid glass, *i. e.* pot metal of two several sheets or layers laid upon each other from the frit, as for example, red and white, blue and white, &c., it is possible to produce many effects of shading by removing more or less of the coloured glass sheet, according to the outline, by grinding with emery. Or the coloured sheet may be ground through to the white glass, and thus coloured ornaments may be given on white ground, especially for the representation of damasked materials. Also, the white parts thus exposed may have a colour given them at pleasure on the opposite side, in order to produce many kinds of effects, or to avoid the necessity of using many pieces when the introduction of another colour in that of the pot metal is indispensable for the effect required.

The coloured pot metal may be painted with intermediate tints of its own principal colour, or even, in order to produce certain effects, may be covered on one of its surfaces with another colour. Thus, a fiery red may be obtained by covering a red overlaid glass on its white surface with the yellow silver colour, and burning it in, or a shade of green by a similar use of the same pigment on a blue overlaid glass. In these operations the widest latitude is left to the talent and practice of the artist.

CHAPTER III.

OF THE PROCESS OF FIRING, OR BURNING IN OF THE COLOURS; AND THE CONSTRUCTION OF THE KILN.

111. THE object kept constantly in view in the foregoing explanation of the processes of glass-painting, has been to bring the practice of this art into the reach of as many hands as possible; and therefore it has been especially endeavoured to point out, not only the most suitable, but also the shortest and easiest methods of operation, in order to show that the processes are much less costly and complicated than generally supposed, and to put the reader as much as possible in the position of being able to construct for himself the requisite apparatus.

This principle has been particularly adhered to, in the following description of the process of firing, and the construction of the necessary kiln; for it will be shown that the operation may be performed in any common kitchen, and that an ordinary fire-place may, with the aid of some fire-bricks, tiles, and iron rods, be made to suffice for the construction of a furnace which shall answer perfectly the purpose intended.

The remaining necessary implements consist of a muffle, an iron charcoal-shovel, a pair of fire-tongs, tongs to extract the trial pieces, and a pot in which to dry the charcoal.

112. The muffle, if it cannot be obtained of cast iron or plumbago, may be made of burnt earthenware, and its size may be regulated according to circumstances. If of the latter material, it must, in order to stand fire well, be constructed of a mixture of two parts fire-clay and one part fine sand, and should be of an oblong four-cornered figure; for example, twelve inches long, ten inches wide, and five inches high. It must, however, be large enough to receive the largest of the sheets to be burnt, without their edges coming in contact with the sides of the muffle.

In the middle of one of the short sides there should be an opening five inches long and a quarter of an inch wide, for extracting the test pieces. The muffle is to be closed with a cover of the same material, having two round holes of about one inch and a half diameter, running out into two tubes about two inches and a half long.

113. To receive the muffle, a four-cornered kiln is to be built, whose interior dimensions should be four inches longer, and as much wider, than the muffle which is to be placed therein.

For this purpose fire-bricks are simply to be laid upon each other, but in such a manner that the wall turned towards the operator may contain an opening three inches high from the bottom and twelve inches wide, for the management of the firing. When it has reached the height of four inches all round, a perfectly horizontal bearing frame is to be formed by laying a pair of iron rods upon the long sides. Upon these the muffle is to be placed, in such manner that the test opening is turned towards the operator.

After the painted glass sheets are laid in the muffle, the walls of the kiln are to be built to such a height as to reach one inch above the tubes of the cover; in doing which, however, another opening three inches and a half wide and two inches high, corresponding to the test opening of the muffle, must again be left in the front wall, or that turned towards the operator.

Both openings of this wall of the muffle must be capable of being closed; the lower one, that of the ash-pit, with a stopper of iron plate filled with clay; the upper one, or the one corresponding to the test opening, with a stone. Each of these stoppers must fit exactly, and be of the same thickness as the wall.

114. The painted glass intended for firing must be laid in the muffle in the following manner. Sprinkle first of all well-burnt lime with water,

and dry it again, when slaked over the fire. Sift this powder through a coarse hair sieve, so as to cover the bottom of the muffle to the thickness of one inch. Carefully level over this layer (since otherwise the glass might become crooked in burning), and lay the sheets upon it near each other, but not so close as to come in contact either with each other or with the walls of the muffle. Then sift another thin layer of lime over them; lay a second set of the pieces of painted glass on the lime, and continue in this manner up to the middle of the muffle, where the opening is made for drawing out the tests. These consist of strips of glass about six or seven inches long and one inch wide, streaked with patterns of the colours which are to be burnt in. They are to be laid in the muffle like the sheets of painted glass, upon a layer of lime, and covered with it in the same manner; and they must be so placed that one end may reach to the middle of the muffle, while the other end projects half an inch out of the test opening before described, in order that they may be laid hold of with the tongs, and drawn out for examination.

After these are placed, the sheets of the painted glass and the layers of lime are to be alternated, as before, until all the glass is placed in, or until the muffle is full. If only one sheet is to be fired, the muffle must be filled with common instead of painted glass, as above directed, and the single sheet to be operated upon must form one of the middle layers. After this the muffle must be closed in.

115. In the two tubes of the cover are to be placed pieces of the same kind of glass as is used to paint upon, five or six inches long and one inch wide; these may be called *watchers;* they are to be placed vertically, and in such a manner that their lower ends may stand on the sheet of lime next under the cover, and their upper ends may project about two inches out of the tubes.

After this, and after the test opening of the front wall is closed with its stopper, the firing may be commenced by strewing glowing charcoal over the hearth of the kiln and to some little distance up the sides, then filling all the interstices between the muffle and the walls of the kiln with charcoal up to the height of the muffle, and afterwards covering the latter in such manner that the *watchers* may project in sight. The whole of the fuel will then soon catch fire.

Proceed to lay across the walls of the kiln some iron bars, and upon these some fire-tiles, so as to cover the kiln as far as an opening in the centre, not quite one foot diameter.

It is here to be remarked, that when the muffle is new, or has not been employed for some time before, it will be safer to heat it to redness previously to using, which is to be done in the above-described manner, exactly as if it contained glass, increasing the fire to a white heat, and allowing the muffle to cool of itself after the fire is removed. When it is quite cold, it may be used with safety.

It is particularly necessary to take care that the heat of the kiln during the process is raised equally on all sides of the muffle; and the fire must also be retained at a uniform glow by the continued addition of fresh fuel.

116. When the muffle reaches a dull red heat, when the *watchers* bend, and when the colours appear clear and perfectly fused upon the test strips (which must have been drawn out and laid upon the top of the kiln to cool slowly), all which customarily takes place about the sixth or seventh hour of the burning, the fire is to be removed by the hearth opening of the kiln, as quickly as possible, but yet with care not to shake or disturb the muffle; all the openings of the kiln must be stopped and luted, and the whole left to cool gradually, which will require between twenty-four and thirty-six hours.

The spare charcoal may be thrown into a pot of water and used again.

After the cooling, the glass sheets are to be taken out of the muffle, cleaned with a brush and lukewarm water, and carefully dried.

117. Should any parts require further painting, and consequently another firing, the pigments

must be mixed the second time with a greater quantity of flux, in order to render them more fusible than those previously burnt in.

Also, the heat of the second burning should be less than that used the first time.

CHAPTER IV.

OF THE OPERATION OF FIXING TOGETHER OR LEADING MOSAIC GLASS.

118. This process is most customarily and properly left to the glazier, who also ought to cut out the pieces of glass. In order, however, to leave nothing wanting for those amateurs who may wish to make the whole of a specimen of the art their own, the following rules may be useful.

Common window lead of the glaziers, but of very small dimensions, is to be laid round one of the middle pieces forming the glass-painting, so as to hold it in the groove of one of its sides, while, in that of its other side, another piece is to be inserted. Continue this, constantly under the guidance of the cartoon, upon which the work may be laid, and working always from the centre of the picture outwards, soldering the several pieces of lead together during the process, by their ends of contact, which may be interlaid in the grooves at the corners where they join.

For this the soft or tin solder (consisting of tin having so much lead melted with it that when bent it does but slightly crackle—commonly one part lead and three or four parts tin) is required, and a common glazier's soldering iron with a copper point should be used for applying it. After this is heated in a charcoal fire, it is to be rubbed in powdered sal-ammoniac and resin, and then on a piece of the solder, a portion of which will adhere to the copper and may be carried to the leaden bars. When the soldering is executed, it will be well to touch over the junctures with dark oil colour, or still better with dilute sulphuric acid, in order to remove the bright metallic lustre, which might otherwise damage the effect of the painting.

APPENDIX.

On the General Nature of Enamel-Painting.

Enamel-painting differs from all other kinds in the vehicle employed for the colours, that is, to hold the parts together, and bind them to the ground they are laid upon. This is glass or some vitreous body, which, being mixed with the colours, and fused, or melted, by means of heat, becomes fluid; and having incorporated with the colours in that state, forms, together with them, a hard mass when cold. It answers, therefore, the same end in this, as oil, gum-water, size, or varnish, in the other kinds of painting.

The glass or vitreous body applied to this purpose of mixing with the colours, in order to bind them to the grounds, is called a flux, and makes one principal class of the substances used in enamel-painting. When this flux is easily fusible, that is to say, melts with a less degree of heat, it is, in the style of those who work in enamel, said to be *soft;* and when it is reluctant to melt, and requires a greater degree of heat, it is called *hard.* These terms are as well applied to the matter of the enamel grounds, and all other vitreous substances concerned, as to the fluxes. It is, in general, a perfection of the flux to be soft, or run easily into fusion. But the great point, with respect to this particular, is, that when several mixtures of colours and fluxes are used at the same time, they should all correspond to each other in the degree of this quality; otherwise some would be rendered too fluid, and perhaps run the matter of the enamel ground into fusion, and mix with it, while others remained solid and insufficiently fused themselves. It is always necessary, likewise, that the enamel of the ground should be considerably harder than the mixtures for the colours; for if they both melt with the same degree of heat, they will necessarily run together.

It being requisite that the body painted in enamel should undergo a heat sufficient to melt soft glass, the matter of such body can only be gold, silver, copper, porcelain, or China-ware, hard glass, and earthenware. And where the metals are used, if the painting be of the nature of a picture, or demand a variety of colours, it is necessary that a ground of white, or some other colour, should be laid on the metal; the body of which ground must necessarily be of the same vitreous nature as the flux, but harder; as nothing else can endure so great a heat that is capable of incorporating with, and binding the matter of the white, or other colour, to the surface of the metal. The grounds, therefore, make another principal class of the substances used in enamel-painting.

The third class is the colours, which must likewise be bodies capable of suffering the heat of melted glass; and such as will either themselves be converted into glass, or kindly incorporate with it in a melted state. This of course confines the matter of such colours to metals, earths, or other mineral bodies; all vegetable and animal substances being calcined and analyzed with a greatly less degree of heat than the lowest sufficient to work enamel.

The fourth kind of substance is called the secondary vehicle; which is, some fluid body for laying on the ground, and working, with the pencil, the flux and colours when mixed together; since, as they form only a dry powder, they could not be used as paint without some such medium. But as this is to serve only for spreading and laying on the matter of the enamel, and not, like other vehicles, to assist in holding the colours together, and binding them to the ground (that being in this kind of painting the office of the flux), it is necessary that it should be some such substance as will evaporate and dry away without leaving any part behind: it would otherwise be heterogeneous matter with regard to the enamel, and consequently injurious to it. Essential oils have been, therefore, used for this purpose, as they have the quality of wholly drying away on the first approach of heat, together with a slight unctuosity, which renders them capable of making the matter of the enamel work properly with the pencil.

On the Art of Gilding Enamel and Glass by Burning.

There are two methods of gilding enamel and glass, by burning or annealing: the one is the producing a cohesion of the gold with the glass or enamel by the intermediation of a flux; the other, by producing the like effect without any. But the principle is the same, nevertheless, in both; and is, in fact, no other than the causing the gold to adhere to the enamel or glass, in consequence of the fusion or approach to that state, either of the flux used, or the body of enamel or glass itself; by which the gold is cemented to such body.

The flux, when any is used, may be either simple glass of borax, or any of the preparations of fluxes powdered.

There are other differences likewise in the manner of this gilding, which respect the state of the gold; for it may be either used in the form of leaf gold, or in that of powder, either mechanically made, or by precipitation.

When leaf gold is employed for gilding enamel or glass in this way, without any flux, the enamel or glass may be moistened with a very weak solution of gum-arabic, and again dried. Being so prepared, it should be breathed upon till it becomes a little adhesive or sticky, and then it should be laid upon a leaf of gold; and if that be not sufficient to cover it, the remaining part must be laid on others, and the work again breathed upon, if it appear dry before the whole surface be gilded. When the gold is thus united to the enamel or glass, by the cementing quality of the gum-arabic, which is used in order to keep it close and even to the body to be gilded, the work is ready for burning.

If the leaf gold be used for gilding enamel or glass with the aid of any flux, such flux, being finely levigated, should be tempered with a very weak solution of gum-arabic, and very thinly spread on the part of the work to be gilded; and when the gum-water is nearly dry, the leaf gold should be laid on the part thus prepared for it; or if the work be kept beyond the time, it must be breathed upon till it becomes sticky: the gold thus fixed on the work, it is in a state proper for burning.

The advantage in omitting to use any flux is the rendering the gold less prominent and uneven, with respect to the body gilded; which is in some cases material. But unless the ground, whether of enamel or glass, be very soft, it requires a strong heat to make the gold take hold of it; and this, in the case of enamel, endangers the ground, or any painting upon it; for if the degree of heat be not very nicely adjusted, the glass or enamel will run into too liquid a state in some instances, and in others not be softened sufficiently to cohere with the gold. The advantage of using a flux lies in avoiding both these inconveniences; and, particularly in the case of very hard glass, the being certain that the gold will cake; which is, without this medium, sometimes dubious. But the flux lying under the gold prevents it necessarily from being so level with the surface, or having the same evenness, as when laid on the body itself without any intermedium.

Before we speak of the method of using the gold in powder for gilding in this way, it is proper to mention the manner of preparing this powder; which may be best made in the following manner: Take any quantity of gold, and dissolve it in aqua regia thus: To 8 ounces of pure spirit of nitre add 2 ounces of sal-ammoniac, scraped perfectly clean, and powdered, which will convert the spirit of nitre to aqua regia. Dissolve, in 4 ounces of this aqua regia, put into a proper phial, half an ounce of purified gold, in the state it is to be had of the refiners, under the name of grain gold. In order to hasten this solution, the phial may be put into a gentle heat, where it must continue till the gold entirely disappears. Take, in the mean time, about the same quantity of aqua regia in another phial, and put into it filings or small bits of pure block-tin, so long as any brisk effervescence arises on the adding fresh quantities: but this must be done gradually, especially if the filings be used; otherwise the mixture will heat so much as to boil over, or break the phial. Drop then thirty or forty drops of the solution of the gold into a half-pint glass of water, and immediately after about fifteen or twenty drops of the solution of tin. The gold will be then precipitated in a red powder from the solution in the aqua regia dropped into the water; and this operation must be repeated till the whole quantity of the solution is thus treated. When the last quantity of the red powder has been precipitated, pour off the clear fluid, and fill the glass with spring water; which, when the red powder has settled, must be poured off likewise. Hold then a sponge wet, but well squeezed, to the surface of the fluid remaining with the powder; and, when as much of the water as can be conveniently separated from it by that means, is drawn off, lay the powder on a marble or porphyry stone to dry, taking great care that it contracts no dust or foulness. When dissolved, make a precipitation of the gold, by putting into the solution slips of copper plate, which must be continued there till they no longer produce any effervescence in the fluid. These slips of copper being then taken out, and the gold adhering to them gently beaten off, the fluid must be poured off from the precipitate, and fresh water put in its place, which must be renewed, in like manner, several times, till the salt formed by the copper and aqua regia is entirely washed from the gold; which, being dried, will be ready for use.

The precipitation may otherwise be made by adding a solution of Roman vitriol, or of copperas, or common green vitriol, to the solution of gold, in the following manner: Take a solution of gold in aqua regia, prepared as above directed; and add to it gradually a solution of green vitriol or copperas in water, until no further precipitation of the gold is made by the addition of a fresh quantity. The solution of the copperas may be made by putting one drachm of it powdered into an ounce of water, and shaking them till they appear to be dissolved; after which the solution must stand, and the clear part be poured off from the sediment, if any be found. The fluid must be poured off from the precipitated gold as soon as it is perfectly subsided, and the precipitation must be well washed by pouring on it several successive quantities of water. Roman or blue vitriol may be employed for this purpose instead of the green, but it is somewhat dearer, and has no advantage over the other. The gold precipitate thus obtained is very bright and shining. A similar kind may be prepared by putting flat bars or plates of copper into the solution of the gold in aqua regia; but the precipitate is of a brown colour, without any lustre or shining appearance.

This method is more expeditious, as the precipitation is instantaneously made. In the present practice, the (*aurum fulminans*) fulminating gold, or precipitation by alkaline salts, is made by those who gild glass in the greatest perfection; and the volatile alkali is employed for the precipitation by the chemist, who prepares it for this purpose. But when this kind of precipitate is chosen, the use of any flux must be avoided, and a very considerable degree of heat applied.

Where it will not answer the trouble to prepare precipitated powders, that formed of leaf gold may be used in its place; but the precipitates are more impalpable powders than can be obtained by any different method, and will take a finer burnish than any other kind when employed in this sort of gilding.

The manner of using the precipitates of gold in gilding of glass or enamel, except with respect to the *aurum fulminans*, may be varied two ways, as well as that of the leaf gold; viz. by adding to it or omitting any flux. The convenience of using flux is the same with that before mentioned, with the further advantage of rendering the gilding extremely durable, even to a degree of bearing to be scraped. But the disadvantages are greater; for not lying under the gold, as in the other case, but being mixed with it, the flux destroys the rich metalline look, and, what is still much worse, in many cases prevents its taking a burnish with the true lustre.

In which way soever the powder is used, it is to be tempered with the oil of spike, and worked as the enamel colours; and the quantity of flux, when any is used, may be a third of the weight of the gold. When the gold is thus laid on, the work is ready for burning; which operation must be performed in the same manner, excepting as regards the degrees of heat, as in the ordinary methods of gilding.

In cases where the glass is very hard, or where the opportunity of a strong heat cannot be conveniently obtained, the expedient of using a flux in the following manner may be adopted with great advantage.

Grind glass of borax to a fine powder, and having tempered it with oil of spike, lay it on the glass where the gilding is to be made. Burn then the glass with the degree of heat that will run the borax; and, when it is cold, apply the precipitate, or leaf gold, and burn it again, as in other cases.

In this manner the advantage of a flux may be gained, without the inconveniences before mentioned, and the gold will take a very gentle heat. It is, indeed, attended with double trouble and hazard; but in the case of using leaf gold, where a very good burnish may be wanted, this method will perhaps be found on the whole the most eligible.

The manner of proceeding for burning or annealing the work in this kind of gilding is the same with the treatment of the enamel or glass in the use of the colours, except that the pieces may either be put into the muffles, or coffins; or, in the case of the glass, if there be no painting, the operation may be performed in the naked fire.

After the work is burnt, if it be designed to be burnished, a proper lustre may be given to it by rubbing the gilded part with a dog's tooth, or with a fine agate, or iron burnishers.

On the Taking of Mezzotinto Prints on Glass, and Painting upon them with Oil, Water, or Varnish Colours.

The painting on glass by means of mezzotinto prints is performed by transferring the ink of the print to the surface of the glass, and thus having obtained a drawing, colouring it by proper pigments tempered with oil, varnish, or oil of a vehicle. This transferring the ink from the print to the glass is effected by cementing the face of the print to the surface of the glass by means of some glutinous body which will not dissolve in water, and then destroying the texture of the paper by water, so that it may be rubbed entirely off from the cement upon the glass,—leaving, at the same time, the whole of the ink of the print upon the cement and glass, in the same manner as if the original impression had been made there.

The particular method of performing this is as follows:

Procure a piece of the best crown glass as near as possible in size to the print to be taken off, and varnish it thinly over with turpentine, rendered a little more fluid by the addition of oil of turpentine. Lay the print then on the glass, beginning at one end, and pressing it gently down in every part in proceeding to the other. This is requisite to prevent any vesicles of air being formed in the laying it on, by the paper touching the cement unequally in different parts; and to settle the whole more closely to the glass, it is well to pass over it a wooden roller of about the diameter of two inches. Dry then the glass, with the print thus laid upon it, at the first, till the turpentine becomes perfectly hard, and afterwards moisten the paper well with water, until it is thoroughly soaked. After this, rub off the paper entirely from the cement, by gently rolling it under the finger, and let it dry without any heat: the impression of the print will be found perfect on the glass, and may be painted over with either oil or varnish colours.

The choice and treatment of the colours for painting in this way upon glass, in either oil or varnish, may be the same as for any other methods; and it is therefore needless to enumerate any further particulars.

On the Devices employed for the more easily obtaining a just Outline in making Designs from Nature; and on the various Methods of Off-tracing, Calking, and Reducing Pictures, Prints, or Drawings.

THE drawing accurately and readily after nature, and depicted representations, by the unassisted hand and eye, requires greater practice and command of pencil than fall to the share of many, who nevertheless may not want abilities to colour or shade a picture or drawing when a proper outline sketch is previously procured. The convenience of quicker despatch is moreover a matter of importance even to those who are most expert in this art. On these accounts, various means have been devised to lead and direct the eye or hand, in forming just outlines of the principal objects which compose the design. These means consist of several methods, founded on different principles.

In the drawing after nature, the interposing a transparent plane is commonly practised; through which plane the objects being seen from a fixed point of view, the outlines of their parts are traced upon it by chalk or some kind of crayon; or such transparent body is divided into squares, through which the objects being viewed, the eye may be enabled to form and dispose them with more certainty, on a paper or other proper ground, divided into a similar number of squares; or some reflected image is obtained by means of a camera obscura, which affords an opportunity both of drawing the figure, and imitating the natural colour of the objects. These are the devices employed for drawing after nature; but where pictures, prints, or drawings are to be copied, various methods are adopted. The most common method is by *off-tracing*, as it is called, which is the laying some transparent substance over the picture, print, or drawing, and passing over the outlines of the principal parts with a pencil or crayon, which delineation is to be afterwards transferred from this transparent body to the ground intended for the painting or drawing. The second method, which is indeed only another kind of off-tracing, practised sometimes in the case of prints and drawings, is effected by laying the originals on the ground of paper or vellum designed for the copy, the back of the original being smeared with black, or with vermilion mixed with a little butter; or a paper so prepared being laid between the original and copy, and tracing over the principal parts of the design with a needle or some other such like instrument, by which means an outline sketch of it will be formed on the ground of the copy. This method is called *calking*, and is performed also in another way, by puncturing or pricking the original print or drawing, and producing an outline on a new ground, by transmitting a coloured powder through the punctured holes. The third is by dissolving part of the printing ink by means of soap, and impressing it on a fresh ground in that state. Another method much practised is the using squares in the manner above spoken of, in the expedients for drawing after nature, except that here they are to be laid upon the picture. This method is likewise applied to the more certain copying of pictures or drawings, where the new design is to differ in magnitude from the original, in which case it is called *reduction*. For this last purpose there is likewise another method employed, by means of a machine hereafter described for off-tracing, and by which, after drawing over the lines of the original, the new sketch may be made greater or less.

The particular manner of using the transparent plane for taking designs from nature is, by framing a piece of tiffany or fine lawn, of the size of the picture or drawing intended, and fixing it so that the whole view of what is to be painted may be seen through it; a sight-board, that is, a flat piece of wood, with a hole in it, being placed parallel to the tiffany or lawn, in such manner that the eye may command the whole view through it, at the same time that the hand may reach with convenience to draw upon it. The outlines of the object, as they appear through the hole in the sight-board, must then be traced out, on the tiffany or lawn, by a crayon formed of white or red chalk, charcoal, or any proper substance, by which means a sketch of the design will be produced. In order to form a more complete drawing from this crude sketch on paper or vellum, the tiffany or lawn containing it must be carefully laid on such paper or vellum in an horizontal position, and, being well fixed down upon it, must be struck with some flat body in every part, by which means the chalk or matter of the crayon will be transferred from the old to the new ground, and produce the same delineation of the object upon it as was before on the other. The impression thus made on the new ground should be then over-traced with a black-lead pencil, and afterwards corrected, if there be occasion, from the natural view through the sight-board; and this paper or vellum will then contain a proper outline drawing, if the design be intended for a painting in water colours. But when this method is pursued with a view to a painting in oil, the tiffany or lawn, after the sketch is drawn, must be laid upon the ground of the intended picture, and proceeded with in the same manner as with the vellum or paper; only, in this case, the over-tracing must be made with some kind of crayon instead of the black-lead pencil.

It is advised by some to use paper made transparent by means of oil of turpentine, instead of the tiffany and lawn; but the use of it is only practicable in this way in a darkened room or other confined place, and the paper thus prepared does not become transparent enough, even then, to show minute or remote objects so distinctly as is necessary. If, however, any choose to use it, the usual preparation of the paper is, only to brush it several times over with oil of turpentine, and to suffer it to dry. The transparency will be much improved if a third of nut or poppy oil be added to the oil of turpentine; or otherwise a little crude turpentine or colourless varnish; any of which will render the oil of turpentine more efficacious for this purpose, and save the trouble and expense of rubbing the paper so often over as is otherwise necessary. The paper employed for this purpose should be that called fan-paper, or, if that cannot be procured, fine post paper may be substituted; and where the design is too large to be contained in one sheet, several may be joined together, by laying the edges of the sheets a very little over each other, and cementing them by isinglass glue, which, if neatly done, will only slightly affect the transparency in the joints. When the original sketch is made on transparent paper, the tracing or drawing may be performed by a black-lead pencil, instead of crayon, which renders the drawing much more perfect and durable; and, being thus completed, it may be used for off-tracing the sketch on any ground intended for a painting in either oil or water. If it be intended for a picture in oil colours, the back of the paper may be smeared with pounded black-lead, charcoal dust, or any powdered crayon; or, what is much better, vermilion mixed with just so much butter as will make it adhere to the paper. It must then be laid on the ground of the picture, and over-traced by a copper or iron stift, or blunted needle, which will make an impression of the sketch on the ground by means of the colour on the back of the paper; or another paper may be coloured, with the black-lead or vermilion, instead of the back of the transparent paper, and being laid between that and the ground, will answer the same end. The means are no way different where the sketch is to be transmitted to paper instead of oil. But in colouring the back of the transparent paper, or that interposed where any such is used, care should be taken that the colour be so wiped off as not to smear the ground, or produce any effect, except where compressed by the instrument in the over-tracing; and this indeed should be regarded to a certain degree even with the oil ground. Where the sketch is large, and made on several sheets of paper, it is convenient to have weights to place on the four corners of the conjoined sheets, to keep them even and steady on the ground. They are best formed of square pieces of lead with handles, and may be about two or three pounds weight each.

The sketch on transparent paper may be otherwise transmitted to any ground by puncturing it with holes made near each other in the lines of the drawing, and then fixing it on the ground, and dusting over it black-lead or any other coloured matter finely powdered, and tied up in a fine linen cloth. This dust passing through the holes of the pricked paper will delineate the sketch on the new ground, so that it may then be over-traced by any kind of pencil or crayon. Glass has been also used in the same way as the lawn or transparent paper, but its texture hinders it from being well managed with chalk, or any crayon or pencil. There is also another method, not commonly practised, by which a sketch might be well obtained by the use of glass. This is by drawing the outlines of the objects with black colour in drying oil, and when the sketch is finished, laying the paper intended to receive the copy gently, and without any rubbing or shifting, on the glass, having first moistened it with water; by which means the black paint will be transmitted to the paper, as the moisture exhales from it, and an impression made sufficiently exact for the purpose.

The manner of assisting the eye, in designing from nature by means of a plane divided into squares, is, by drawing cross lines parallel to each other on tiffany or lawn framed, or on transparent paper, or glass. This may be done with common writing ink, or any other way that will render the lines visible; and the divided plane must be then placed before the sight-board in the same manner as was before directed for tracing the outlines. The ground on which the sketch is intended to be taken must be also formed into an equal number of squares; and the objects, being seen through the squares of the transparent plane, will by this means be much more easily disposed in their proper situation, and formed of a just magnitude, by placing them in the corresponding square of the ground, than where the eye had no such medium to compare and judge by. But though the above substances are most commonly used, there is a more simple and effectual way of doing this, which is, by making a frame of a proper size, and dividing the area which it forms into squares, by threads of a moderate thickness. In this way the objects to be drawn are consequently more within the power of the eye than when the most transparent body is used. The drawing by the assistance of squares, to those who have the least command of hand, is by much the most expedient way. But in order to render this or the other methods more commodiously practicable, where it is to be done in the open air, a portable machine should be made for supporting the frame of the transparent plane, and also the sight-board. This machine may be constructed by joining three long legs together, in the manner of the surveyors' instruments, in a block, and fixing the frame, by means of a foot which will slide into the same box, that it may be raised higher or lower. The sight-board must have a foot likewise, by which it may be raised higher or lower; though this must not be fixed into the block, but into a sliding piece, which must pass through the block horizontally, so that the foot of the sight-board being fixed into it at right angles, the board may be brought nearer to or drawn further from the transparent plane at pleasure.

The second method used to facilitate the drawing after nature, namely, by the reflected image of the object, is performed by the camera obscura, of which a portable kind adapted to this purpose is commonly made by the opticians. It is needless, therefore, to give any description of these instruments, and the structure of them immediately explains the manner of their use on a very slight examination. Where they are not at hand, and a prospect through any particular window is desired to be taken, an occasional camera may be formed. This is to be done by boring a hole through the window-shutter at a convenient height, and putting one of the glasses, called the ox-eye, into the hole; when, all other light being shut out, except what passes through this hole, and a proper ground of paper or vellum, &c. being held at a due distance from the hole, the reflected image of the prospect will be formed upon the ground. If this ground be formed of paper, and fixed steady by a proper frame, the image will appear very perfectly on the reverse of it, and the artist may stand at the back, and trace the outlines of the necessary parts with great convenience.

Though the taking views of nature by the camera has several conveniences, and seems very advantageous, there is one very material objection to its use. This is, that the shadows lose their force in the reflected image; and objects, by the refraction, are made to appear rounder, or different sometimes both in their magnitude and site, from what they really are; which being opposed to the truth of any drawing, almost wholly destroys the expedience there would be otherwise found in this manner.

The method of making sketches of outlines from pictures, prints, or drawing by off-tracing, is performed by a variety of methods. The most common, where the size of the painting does not forbid it, is to take a sheet of paper prepared by oil of turpentine, or the other means, as above directed for the taking views from nature; and, having fastened it even on the picture or print to be copied, to trace over the principal parts with a black-lead pencil. By this means an outline being obtained, it may be imparted to any other ground, in the manner before described, when the same kind of outline is formed by drawing after nature. Where larger pieces are to be copied, lawn and tiffany may be used, instead of the transparent paper; or several sheets of the paper may be joined together by means of isinglass glue; and when the outline is traced by chalk, or other proper crayon, the subsequent proceeding may be similar, in this case, as above, where the same kind of outline is taken from nature. Goldbeaters'-skin and horn, as prepared in plates for lanterns, as also the talc or fossil isinglass, and dried hog's bladder, have been likewise applied to this purpose. But where horn or isinglass are used, being rigid bodies that will not yield to impart an impression by retracing, they may be best treated in the manner above advised, in the case of glass, when employed for taking views from nature, which is, by tracing the outlines with black in oil, and printing a new ground of paper with it.

Another common method of off-tracing, in the case of prints or drawings, is to fix them against a window or other hard transparent body placed in a strong light, in a perpendicular position, and to put a piece of paper, vellum, or any other body sufficiently transparent, before them, to perform the off-tracing, by the view which is this way given of the objects in the print or drawing.

The other method of off-tracing, called *calking*, which is sometimes practised in the case of prints and drawings, is performed by tracing on the print or drawing itself, instead of the transparent body laid over it, as in the other manner. The back of it must be previously prepared by rubbing it over with black-lead powdered, or other such matter; or a paper blacked on the under-side may be used, instead of blackening the print or drawing. By either of these methods an outline will be made on any ground of vellum or paper laid under the print; and if several grounds of very thin paper be laid together under the print, with each a blackened paper over them, so many impressions may be made at one time. The same effect may be produced by puncturing or pricking out the proper outlines in the print or drawing, and then using it for imparting the sketch to another ground, with the black-lead powder, &c. in the manner above described in treating of the use of the oiled paper. When the print or drawing is thus prepared by puncturing, it may be employed for transmitting the sketch to any number of grounds.

The manner of using soap for taking off the impression of a print on a new ground is this: Smear the original over with the common soft soap, commix with water till it be of the consistence of a thin jelly, and then lay it even on the ground intended to receive the impression, which must be also previously moistened with water; after which, being covered with several other papers, the whole must be compressed, by passing a wooden roller over them, or by rubbing strongly on them with the calender-glass used for glazing linen, or by any similar means. The impression of the original will thus be imparted to the new ground, which must be first dried, and then carefully washed with a sponge and water to take off the soap. It has been said by some that this treatment will do very little injury to the original print; but, besides the impracticability of ever thoroughly cleansing it from the soap, a part of the printing ink is taken from it, and a proportionable share of the effect of the original impression destroyed.

A method parallel to this is sometimes used with prints and drawings, which is by holding them up to the light, and tracing the proper outlines on the back with a black-lead pencil, or any kind of crayon, and then laying the traced side on a ground proper to receive the impression, going over them with a roller or calender-glass, in the same manner as when the impression is taken by means of soap. On the same principle, in the case of compartments, cyphers, or any other regular figures, where both sides are alike, when one half is drawn or traced, the other half may be procured by doubling the paper exactly in the place where the two halves should join, and then pressing or rolling over the outside of the sketched part. By this treatment a corresponding impression of the design will be made on the other side, and the whole sketch will be finished without the trouble of drawing or tracing out the second half.

The method of copying designs by the use of the squares, either in order to paint in equal magnitude, or with a view to reduction, is this: Divide the original into a convenient number of squares, by ruling lines across it with any kind of crayon, and then do the same on the ground in a corresponding manner. The squares on the new ground may be either increased, diminished or made equal as to their size, with respect to those of the original, according to the intended proportion of the new piece. The principal use of the squares, in this case, is so much the same as when they are applied to the taking drawings from nature, that it is needless to dwell longer on them. It may be here stated, that to those who can draw at all, the use of the squares is much more advisable, as well as in drawing after nature, than any of the other methods; it is much more improving, and, on the whole, less troublesome, to make a correct sketch in that way than by any other.

The manner of reduction, or, if that be not necessary, of tracing out an outline, where the magnitude of the original is to be preserved, by the machine above mentioned, which was formerly called a *parallelogram*, and by some a *mathematical compass*, cannot be properly understood without an explanation of the construction of the instrument.

This instrument is composed of a board or table, with ten pieces of wood fixed upon it, in a moveable manner; and by such a construction, that when one is moved, the whole of the rest move also similarly, with respect to the directions, but under greater or less angles. The board or table may be of fir deal, and is usually made in the form of a parallelogram. The magnitude of it, as well as of the other parts of the machine, must be according to that of the pictures, &c. intended to be used for reducing. But for the sake of giving the comparative proportions, it may be stated at three feet in length, and the breadth may be about a foot and a half. It must be planed very even, but should not be of too thin a substance, and it must be covered with cloth stretched even upon it, and fastened down to it. The ten pieces of wood must be formed like rulers used for writing; and in the proportion here taken, they may be a foot long, and about half an inch in breadth, and the fifth or sixth of an inch in thickness. They must be fastened to each other in such manner that every one must be crossed by another in the centre, and by two others at such distance from the centre as exactly divides the two half-lengths on each side of it; except the two which form the extremities, and can be only crossed in the centre and in the middle of one part, which, in each extremity, will be the part opposite to that so crossed in the other, as will immediately appear on the pieces being laid together in the position here directed. The fastening must be by pins or rivets, on which each piece may be turned with perfect freedom; and near each end of every piece must be made a hole or a female screw, into which a crayon, portcrayon, or pencil, may be fixed, either by, or without, a screw. At the ends of those pieces which make the extremities there must be a smaller hole for a pin to be passed through to fasten the conjoined pieces to the board. In order to the more commodiously fixing the several parts of the instrument to the board or table, it may be proper to have female screws at the places of the table where the rulers are to be pinned down, according to the different applications of the instrument; and the pins for fastening the respective parts must, in this case, have male screws at their extremities, correspondent to the female screws in the table. By these directions, closely followed, the parts of the instrument may be completely formed, and put together.

Colouring or Washing Maps, Prints, &c.

THE colouring maps or other prints is performed either by spreading opaque colours so thinly on the subject that the full effect of the printing may appear under them, or by using transparent colours which stain the ground and dry away without leaving any opaque body: this last method is called *washing.*

The using opaque colours, or such as have a solid body, in this way on prints, depends entirely on the kind of vehicle used; for if the colour be so suspended by the vehicle that it can be spread equally, it may be applied to this purpose with success; and such as are very strong and bright, even though of the most opaque body, as vermilion, verditer, ultramarine, or turpeth mineral, will answer the end. The best method of doing this, is the using the isinglass size, prepared with sugar or honey, according to the following directions: Take three quarters of an ounce of gum-arabic, and a quarter of an ounce of gum-senegal. Powder them, and then tie them up in a linen rag, leaving so much unfilled room in the bag as to admit its being flattened by the pressure of the hand. Having squeezed the bag till it is flat, put it into a quart of hot water, and there let it continue, moving it sometimes about, and stirring the water, for about twenty-four hours. The gums will then be dissolved, and the bag must be taken out. The fluid being divided into two parts, to one half of it add a quarter of an ounce of white sugar-candy powdered, and keep the other in its pure state.

The following method is the most advisable for the making the isinglass size: Take half an ounce of the beaten isinglass, and a pint and half of water. Boil them till the isinglass be wholly dissolved, and then strain the fluid, while hot, through a linen rag. Divide the size thus made into two parts, and to one of them add an equal measure of hot water, by which means a strong and weak size will be likewise obtained. This makes the colours of this sort work so freely that they may be diffused almost as easily as the transparent kinds, and with nearly as good effect. But it is proper in most cases to dilute the composition more for the washing of maps, and spreading the colour over large surfaces.

Besides the opaque, there are a number of colours which are semi-transparent, and yet have a body in a greater or less degree. These are carmine, bistre, and gall-stone, in the first degree, with lake and Prussian blue in the second; all which may be treated in the same manner, but require very different proportion in the strength of the size.

The transparent colours should be preferred for this purpose to either of the other kinds, as their effect is better, and they require no preparation. The colours are, *for red,* red ink,—*for blue,* litmus,—*for green,* sap green and verdigris (in vinegar),—*for yellow,* gamboge, the yellow berry wash and turmeric wash,—*for purple,* the logwood wash and archil,—*for brown,* Spanish liquorice,—and *for black,* Indian ink. These require only to be dissolved in water, which should be more copiously added when employed for washing prints or colouring large grounds of any kind.

It must be carefully observed, in employing the opaque or semi-transparent colours, never to cover any parts so strongly as to prevent the distinct appearance of the shades of the printed design.

In the *illuminating* (as it is called) maps, as little peculiar in the manner is necessary as in the case of other prints; only, the intent of colouring them being to distinguish the divisions of the maps with respect to countries, districts, &c., care must be taken not to lay the fluid colours on so copiously as to flow beyond the limits of what they are intended to cover. The rest depends on the so disposing of the variety of colours in different parts as to give them a strong and pleasing effect, which must depend more on fancy and good taste than on any rules. There is indeed one thing in particular, which, it may be proper to remark, should be always avoided : it is the laying such colours as have any affinity or likeness close to each other; for by an error in this particular they will be rendered much less effectual with respect to the purpose they are to serve; as it is by such a disposition made more difficult to the eye to distinguish the limits and bounds they are intended to mark out. And moreover, for want of due apposition, the diversification of the colours is made less pleasing, when they are seen at a distance, and considered only with respect to their ornamental appearance. There is one other rule which is more especially necessary to be observed, though many think they are giving most perfection to their work when they most deviate from it: it is, the never using too strong and deep colours for this purpose, as they render the legible characters of the maps less distinct and perceptible. Such a practice is therefore repugnant in a certain degree to the principal intention of the maps, and moreover gives them a tawdry glaring appearance which is very inconsistent with good taste, one great principle of which is simplicity, and the avoiding a false and unmeaning showiness.

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